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## EUROPEAN PATENT APPLICATION

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(54) Magnet for use in a drift tube of an X-ray tube.

(57) An improved magnetic core for focussing electrons leaving the accelerating anode of an X-ray tube has rounded poles. Non-magnetic sealing material is placed between the poles and the magnetic core is sealed to the accelerating anode and to the target assembly, so that no separate drift tube is needed.

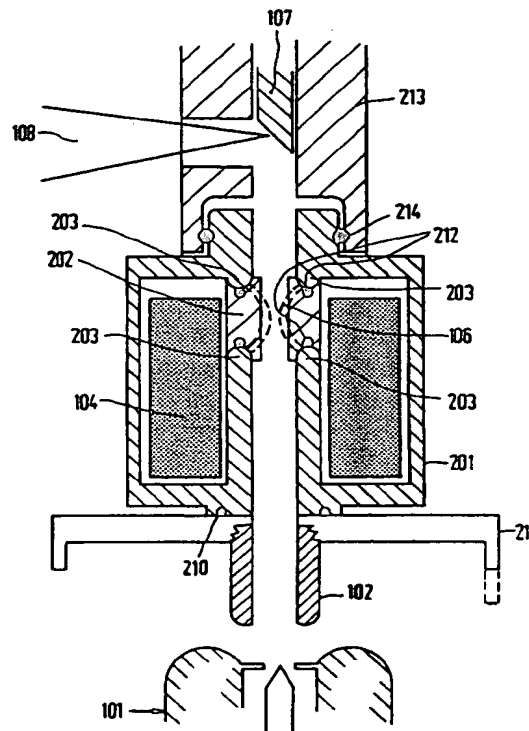


FIG.2

The present invention relates to an improvement in the field of an X-ray tube provided with a magnetic lens system.

Fig. 1 is a cross-section of relevant interior portions of a conventional X-ray tube. Electrons boil off a cathode 101, are accelerated by an accelerating anode 102, pass through a drift tube 103, and hit a target anode 107. The target anode 107 then produces X-rays 108. A magnetic field 106 is produced in the drift tube 103 at the poles 109 of a magnetic core 105 and windings 104. The poles are sharply angled. The magnetic field 106 focuses the electrons passing through the drift tube. The drift tube 103 maintains a vacuum while the electrons pass through it.

Improvements in the magnetic core are needed to improve focus and field strength.

An object of the invention is to improve the magnetic core 105.

Fig. 1 is a cross-section of relevant interior portions of a conventional X-ray tube.

Fig. 2 is a cross-section of relevant interior portions of an X-ray tube using an improved magnetic core.

In Figure 2, a solenoid magnetic core 201 according to the invention is shown in cross-section. The core has rounded poles 203, at which the magnetic field 106 is produced. The rounded poles are preferably semicircular in cross-section.

In the prior art, it was believed that sharply angled poles would produce a stronger magnetic field because of the effects produced by the corners. However, experiments have shown that the corners in the sharply angled poles saturate at a low magnetic field. The rounded poles have proven therefore to have given a stronger magnetic field.

The core 201 is sealed with O-rings 210 to the tube shell 211 which is sealed to the accelerating anode 102 and the target anode 107. Non-magnetic material 202 such as aluminum is sealed with O-rings 212 to the poles 203. The target assembly 213 is sealed to the magnetic core 201 with O-rings 214. Consequently, the core 201 itself serves as a drift tube and eliminates the need for a separate drift tube 103. It has been found experimentally that using the core in this way, instead of a separate drift tube, requires less current to be used in the windings 104 and allows a smaller, more efficient focus, magnet, though alignment of the electron beam and magnet assembly is more critical, due to the smaller dimension.

#### Claims

1. An X-ray tube comprising:
  - a) a cathode;
  - b) an accelerating anode for accelerating electrons emanating from the cathode;

c) a magnetic lens system for focussing electrons leaving the accelerating anode, a magnet thereof including a magnetic core and

d) a target anode assembly for producing X-rays upon electron bombardment

characterized in that

the core of the magnet is provided with magnetic saturation avoiding rounded pole terminals.

2. An X-ray tube as claimed in Claim 1, characterized in that the pole terminals are semicircular in cross-section.

3. An X-ray tube comprising:

a) a cathode;

b) an accelerating anode for accelerating electrons emanating from the cathode;

c) a magnetic lens system for focussing electrons leaving the accelerating anode, a magnet thereof including a cylindrical magnetic core; and

d) a target anode assembly for producing X-rays upon electron bombardment,

characterized in that non-magnetic material is provided between poles of the magnet core; and said core being vacuum-tight connected with the accelerating anode; and the target assembly; the core acting as drift tube in the X-ray tube.

4. A magnetic lens system for an X-ray tube as claimed in Claim 1, 2 or 3.

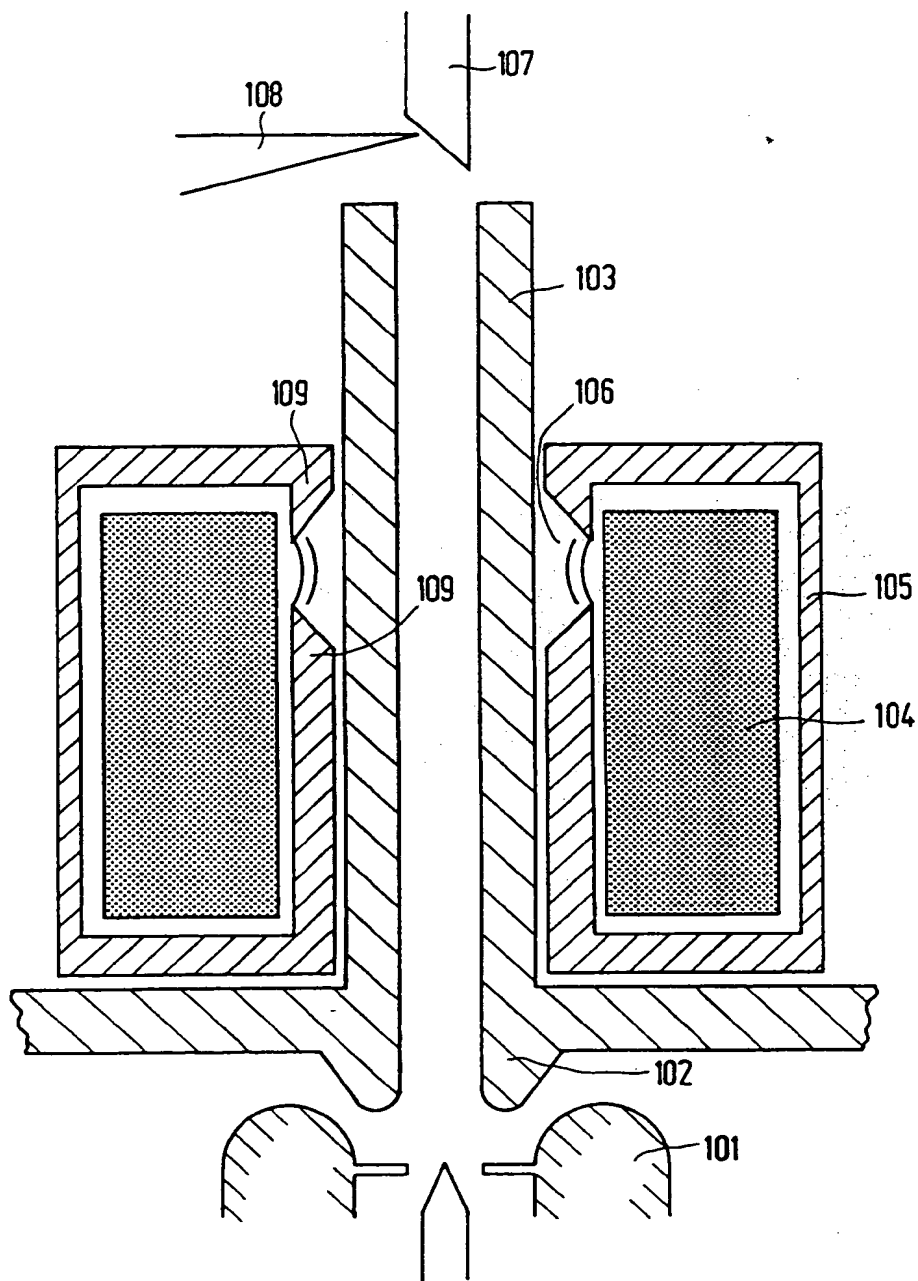
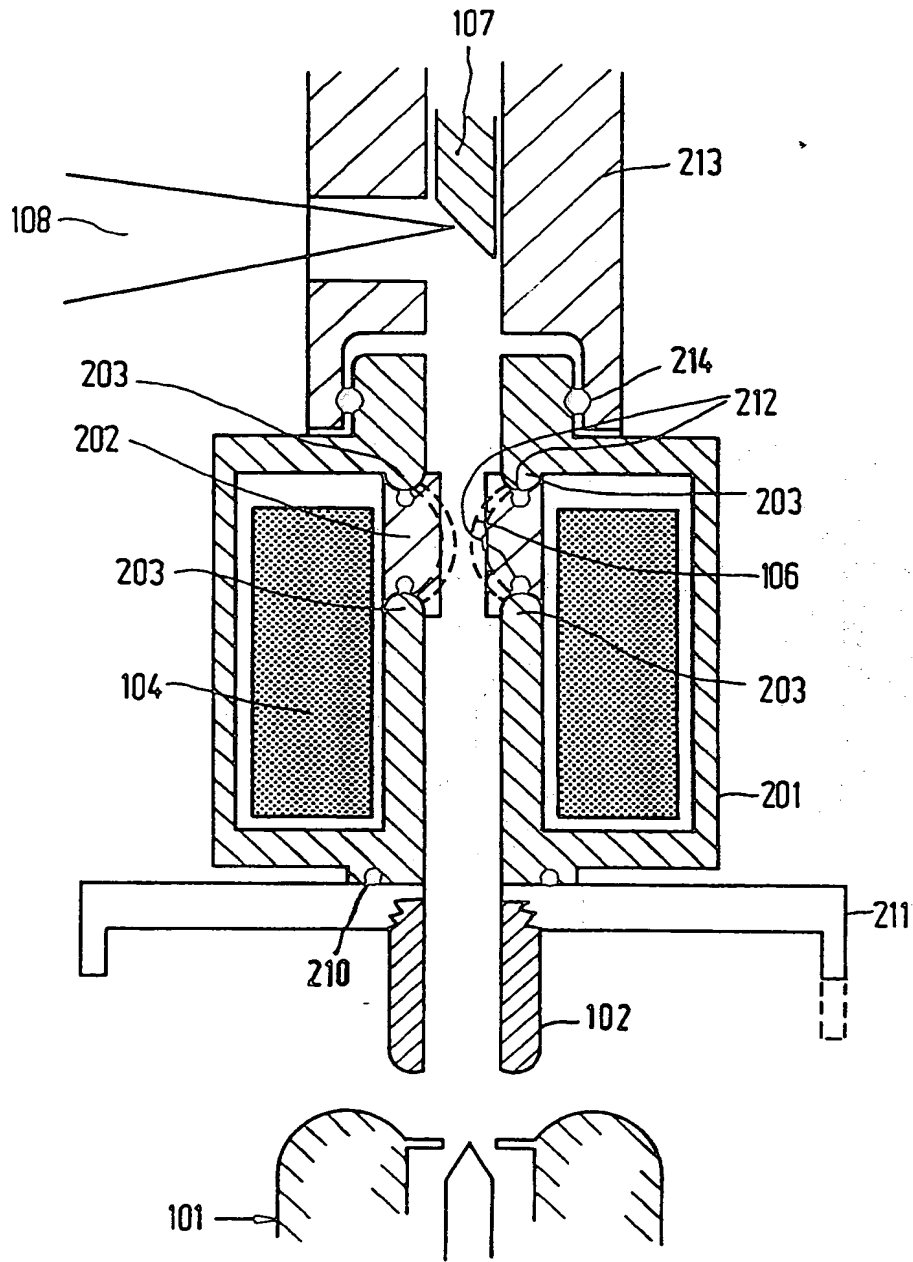


FIG.1



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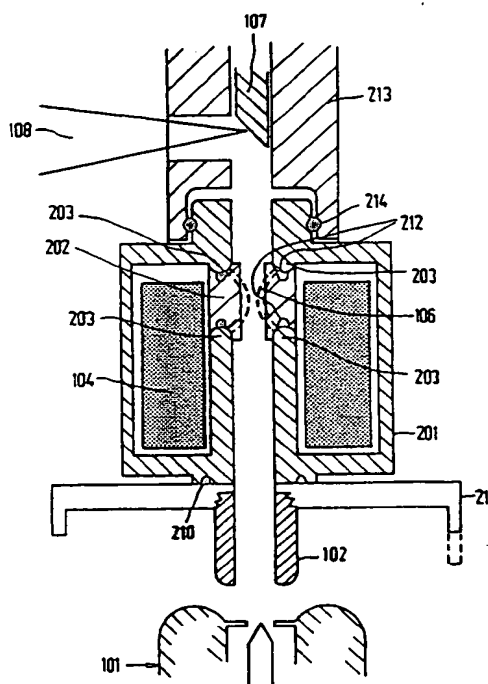


FIG. 2



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## EUROPEAN SEARCH REPORT

Application Number

EP 91 20 2142

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	US-A-3 197 678 (PRIMAS) * Column 2, line 8 - column 3, line 11; column 4, lines 8-37; column 6, lines 3-11; figures * ---	1,2,4	H 01 J 35/14
Y	EP-A-0 096 824 (REINHOLD) * Page 8, lines 15-32; figure 1 * ---	1,2,4	
A	DE-C- 893 100 (SIEMENS-REINIGER WERKE) * Page 1, lines 19-32; figure 1 * ---	1,4	
A	US-A-3 141 993 (HAHN) * Figure 5; column 4, lines 63-74 * -----	1,4	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H 01 J H 01 F G 21 K
<del>The present search report has been drawn up for all claims</del>			
Place of search THE HAGUE		Date of completion of the search 14-01-1992	Examiner COLVIN G.G.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	



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### CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.
- ☐ Only part of the claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid,  
namely claims:
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

### LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions,  
namely:

see sheet -B-

- ☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid,  
namely claims:
- ☒ None of the further search fees has been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims.

namely claims: 1, 2, 4



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EP 91 20 2142

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# LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims 1,2,4(4 as far as dependent upon 1 or 2) :  
Magnetic saturation avoiding rounded pole terminals.
2. Claims 3,4(4 as far as dependent upon 3) :  
Vacuum tight pole gap inserts.



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